

# New Hampshire Volunteer Lake Assessment Program

## 2003 Biennial Report for White Oak Pond Holderness



NHDES  
Water Division  
Watershed Management Bureau  
29 Hazen Drive  
Concord, NH 03301



# OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **WHITE OAK POND, HOLDERNESS**, the program coordinators have made the following observations and recommendations:

We would like to congratulate your group on sampling twice this season! However, we would like to continue to encourage your group to conduct more sampling events in the future. Typically we recommend that monitoring groups sample three times per summer (once in June, July, and August). We understand that the number of sampling events you decide to conduct per summer will depend upon volunteer availability, and your monitoring group's water monitoring goals and funding availability. However, with a limited amount of data it is difficult to determine accurate and representative water quality trends. Since weather patterns and activity in the watershed can change throughout the summer, from year to year, and even from hour to hour during a rain event, it is a good idea to sample the lake/pond at least once per month over the course of the season.

## **FIGURE INTERPRETATION**

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake/pond has been monitored through the program.

Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. **The mean (average) summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 7.02 ug/L.**

The current year data (the top graph) show that the chlorophyll-a concentration **decreased** from July to August. The chlorophyll-a concentration on both sampling events was **less than** the state mean. Overall, the statistical analysis of the historical data (the bottom graph) shows that the mean annual chlorophyll-a concentration has **not significantly changed** since monitoring began in **1989**. Specifically, the mean annual chlorophyll concentration has **varied**, but has not *continually increased* or *decreased* since monitoring began. (Note: Please refer to Appendix E for the detailed statistical analysis explanation and data print out.)

While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes/ponds, phosphorus is the nutrient that algae depend upon for growth. Algal concentrations may increase with an increase in nonpoint sources of phosphorus loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). Therefore, it is extremely important for volunteer monitors to continually educate residents about how activities within the watershed can affect phosphorus loading and lake/pond quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake/pond transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the lake/pond has been monitored through the program.

Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. **The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.**

The current year data (the top graph) show that the in-lake transparency **increased very slightly** from July to August. The transparency in July was **slightly less than** the state mean, while the transparency in August was **approximately equal to** the state mean.

Overall, the statistical analysis of the historical data (the bottom graph) show that the mean annual in-lake transparency has **not significantly changed** (either *increased* or *decreased*) since monitoring began in **1989**. Specifically, the transparency has

remained **relatively stable, ranging between approximately 3 and 4 meters.**

(Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

Typically, high intensity rainfall causes erosion of sediments into lakes/ponds and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from DES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake/pond has joined the program.

Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration **increased slightly** from July to August. The phosphorus concentration in July was **slightly less than** the state median, while the concentration in August was **slightly greater** than the state median.

The historical data show that the 2003 mean epilimnetic phosphorus concentration is **approximately equal to** the state median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration **decreased slightly** from July to August. The phosphorus concentration on both sampling event was **greater than** the state median.

Overall, the statistical analysis of the historical data show that the phosphorus concentration in the epilimnion (upper layer) and the hypolimnion (lower layer) has **not significantly changed** since

monitoring began in **1989**. Specifically, the mean annual phosphorus concentration in the epilimnion has remained **relatively stable, ranging between approximately 8 and 12 ug/L**. The phosphorus concentration in the hypolimnion has **fluctuated**, but has not *continually increased or continually decreased* since monitoring began.

It is also important to point out that the phosphorus concentration in the hypolimnion has generally been **greater than** in the epilimnion. This suggests that the process of **internal phosphorus loading** is occurring in the hypolimnion. (Please refer to the discussion of Table 9 and 10 for a more detailed explanation of internal phosphorus loading).

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands.

#### **TABLE INTERPRETATION**

➤ **Table 2: Phytoplankton**

Table 2 (Appendix B) lists the current and historic phytoplankton species observed in the lake/pond. The dominant phytoplankton species observed this year were ***Dinobryon*, *Chrysosphaerella*, and *Synura* (which are all golden-brown algae)**.

Phytoplankton populations undergo a natural succession during the growing season (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typical in New Hampshire's less productive lakes and ponds.

➤ **Table 4: pH**

Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish. A pH between 6.5 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.5**, which indicates that the surface waters in

state are slightly acidic. For a more detailed explanation regarding pH, please refer to the “Chemical Monitoring Parameters” section of this report.

The mean pH at the deep spot this season ranged from **6.14** in the hypolimnion to **6.54** in the epilimnion, which means that the water is ***slightly acidic***. As organic matter is decomposed on the lake bottom, acidic by-products are produced, which may explain the lower pH (meaning higher acidity) in the hypolimnion.

Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH.

➤ **Table 5: Acid Neutralizing Capacity**

Table 5 (Appendix B) presents the current year and historic epilimnetic ANC for each year the lake/pond has been monitored through VLAP.

Buffering capacity or ANC describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. The mean ANC value for New Hampshire’s lakes and ponds is **6.7 mg/L**, which indicates that many lakes and ponds in the state are “highly sensitive” to acidic inputs. For a more detailed explanation, please refer to the “Chemical Monitoring Parameters” section of this report.

The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) continues to remain ***less than*** the state mean. Specifically, the mean annual ANC this season was 3.45 mg/L, which indicates that the lake/pond is ***critically sensitive*** to acidic inputs (such as acid precipitation).

➤ **Table 6: Conductivity**

Table 6 (Appendix B) presents the current and historic conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current. The mean conductivity value for New Hampshire’s lakes and ponds is **62.1 uMhos/cm**. For a more detailed explanation, please refer to the “Chemical Monitoring Parameters” section of this report.

The conductivity has ***gradually increased*** in the lake/pond and inlets since monitoring began. Specifically, the mean annual epilimnetic concentration has ***increased*** (meaning *worsened*) by ***approximately 3.5 percent*** per sampling season during the sampling period **1989 to 2003**. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

Typically, sources of increased conductivity are due to human activity. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake/pond), agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity.

At White Oak Pond, it is possible that a local landfill may be leaching materials into the ground water and into one of the tributaries that flows into the lake. If the landfill was contributing leachate the tributaries (eventually into the lake), sampling would likely show high levels metals (such as manganese and iron) in the nearby tributary.

It is also possible that de-icing materials applied to nearby roadways during the winter months may be increasing the conductivity in the tributaries and in the lake. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride).

Since we do not know if either of these sources are contributing to elevated conductivity levels in the tributaries and in the lake, we recommend that the **Lamb Swamp Inlet**, the **Dump Inlet**, and the **epilimnion** be sampled for iron, manganese, chloride, and sodium on each sampling event during the 2004 sampling season. (Please note that there will be an additional cost for each of these samples, but it should not take much additional time out in the field to collect these samples.)

*For a detailed explanation on how to collect these additional samples, please contact the VLAP Coordinator. In addition, it would be best to schedule the annual biologist visit for June so that your monitoring group can be trained how to collect these samples.*

➤ **Table 8: Total Phosphorus**

Table 8 (Appendix B) presents the current year and historic total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The total phosphorus concentration was **elevated** in the **Stone Bridge Inlet** on the July sampling event this season. This station has had a history of **fluctuating** total phosphorus concentrations. We recommend that your monitoring group conduct stream surveys

and storm event sampling along this inlet so that we can determine what may be causing the increases.

*For a detailed explanation on how to conduct rain event and stream surveys, please refer to the 2002 VLAP Annual Report “Special Topic Article”, or contact the VLAP Coordinator.*

➤ **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**

Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2003 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the “Chemical Monitoring Parameters” section of this report for a more detailed explanation.

During this season, and many past sampling seasons the lake/pond has had a lower dissolved oxygen concentration and a higher total phosphorus concentration in the hypolimnion (the lower layer) than in the epilimnion (the upper layer). These data suggest that the process of **internal phosphorus loading** is occurring in the lake/pond. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion (as it has been in July and August during many past seasons), the phosphorus that is normally bound up with metals in the sediment may be re-released into the water column.

As discussed in the 2002 annual report, low dissolved oxygen concentration and internal phosphorus loading are difficult problems to solve unless there is a source of funding to provide restorative actions. The most cost effective means to reduce the effect of internal phosphorus loading to the lake is to reduce the total phosphorus load from the watershed (external phosphorus) through a watershed phosphorus management plan.

Following are a few in-lake restoration treatments for internal phosphorus loading:

**1. Hypolimnetic Aeration:** Air (oxygen) is diffused into the hypolimnion to oxidize reduced anoxic (containing no oxygen) sediments. The system can run during periods of anoxia; sometimes June through August. This usually reduces internal phosphorus loading. The cost of this treatment would probably be in the \$9,000 to \$10,000 range (installed) with monthly electric costs. The costs would vary with the model purchased.

**2. Aluminum Salts:** Injection of aluminum salts into the hypolimnion would significantly decrease internal phosphorus loading and may restore oxygen for a year or two because of the toxicity of the aluminum to the bacteria that decompose organic matter. The cost will range from \$1000 to \$1500 per hectare (1 hectare = 2.471 acres) treated.

**3. Bacteria Additives:** Photosynthetic bacteria are added to the pond bottom to compete with algae for the available phosphorus. Photosynthetic bacteria have also been reported to break down bottom organic matter. There is little research on additives and the manufacturer claims they work best with aeration. Costs for additives may range from \$1000 to \$5000 per summer.

➤ **Table 11: Turbidity**

Table 11 (Appendix B) lists the current year and historic data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the “Other Monitoring Parameters” section of this report for a more detailed explanation.

The turbidity of the **hypolimnion** (lower layer) sample was elevated on the July sampling event. This suggests that the lake bottom is very turbid due to organic decomposition or that the lake/pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling. When the lake/pond bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting the hypolimnion sample, please check to make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

➤ **Additional Comments:**

On October 28, 2003, volunteer monitors Galen Beach and Janet Cocchiaro met with Jody Connor (DES Limnology Center Director) and Andrea LaMoreaux (VLAP Coordinator) to discuss the quality of White Oak Pond and also to devise a sampling plan for future sampling seasons.

All agreed that volunteer monitors should try to sample the inlets just prior to where they meet the lake so that we can better determine the quality of water that flows into the lake.

In addition, it was discussed that a biologist would speak at the annual White Oak Pond meeting during the summer of 2004. Please contact Jody Connor at 271-3414 soon to set up a date!

## OBSERVATIONS AND RECOMMENDATIONS

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2003

### **DATA QUALITY ASSURANCE AND CONTROL**

#### **Annual Assessment Audit:**

During the annual visit to your lake/pond, the biologist conducted a “Sampling Procedures Assessment Audit” for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled out an assessment audit sheet to document the ability of the volunteer monitors to follow the proper field sampling procedures (as outlined in the VLAP Monitor’s Field Manual). This assessment is used to identify any aspects of sample collection in which volunteer monitors are not following the proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples that the volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an **excellent** job collecting samples on the annual biologist visit this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

#### **Sample Receipt Checklist**

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did an **excellent** job when collecting samples and submitting them to the laboratory this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the laboratory staff to contact your group with questions, and no samples were rejected for analysis.

### **NOTES**

- **Monitor’s Note (7/23/03):** Heavy rain while sampling
- (8/28/03):** Stone Bridge sample taken on lake side; wind was strong in lamb swamp area, unable to get as close as usual to inlet

**USEFUL RESOURCES**

*Acid Deposition Impacting New Hampshire's Ecosystems*, ARD-32, NHDES Fact Sheet, (603) 271-3505, or [www.des.state.nh.us/factsheets/ard/ard-32.htm](http://www.des.state.nh.us/factsheets/ard/ard-32.htm).

*Aquarium Plants and Animals: Don't leave them stranded*. Informational pamphlet sponsored by NH Fish and Game, Aquaculture Education and Research Center, and NHDES (603) 271-3505.

*Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials*, NHDES-WD 97-8, NHDES Booklet, (603) 271-3503.

*Camp Road Maintenance Manual: A Guide for Landowners*. Kennebec Soil and Water Conservation District, 1992, (207) 287-3901.

*Comprehensive Shoreland Protection Act*, RSA 483-B, WD-SP-5, NHDES Fact Sheet, (603) 271-3503 or [www.des.state.nh.us/factsheets/sp/sp-5.htm](http://www.des.state.nh.us/factsheets/sp/sp-5.htm).

*Erosion Control for Construction in the Protected Shoreland Buffer Zone*, WD-SP-1, NHDES Fact Sheet, (603) 271-3503 or [www.des.state.nh.us/factsheets/sp/sp-1.htm](http://www.des.state.nh.us/factsheets/sp/sp-1.htm)

*Impacts of Development Upon Stormwater Runoff*, WD-WQE-7, NHDES Fact Sheet, (603) 271-3503, or [www.des.state.nh.us/factsheets/wqe/wqe-7.htm](http://www.des.state.nh.us/factsheets/wqe/wqe-7.htm)

*Iron Bacteria in Surface Water*, WD-BB-18, NHDES Fact Sheet, (603) 271-3503 or [www.des.state.nh.us/factsheets/bb/bb-18.htm](http://www.des.state.nh.us/factsheets/bb/bb-18.htm)

*Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes*, WD-BB-9, NHDES Fact Sheet, (603) 271-3503 or [www.des.state.nh.us/factsheets/bb/bb-9.htm](http://www.des.state.nh.us/factsheets/bb/bb-9.htm).

*Management of Canada Geese in Suburban Areas: A Guide to the Basics*, Draft Report, NJ Department of Environmental Protection Division of Watershed Management, March 2001, [www.state.nj.us/dep/watershedmgt/DOCS/BMP\\_DOCS/Goosedraft.pdf](http://www.state.nj.us/dep/watershedmgt/DOCS/BMP_DOCS/Goosedraft.pdf).

*Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act*, WD-SP-2, NHDES Fact Sheet, (603) 271-3503 or [www.des.state.nh.us/factsheets/sp/sp-2.htm](http://www.des.state.nh.us/factsheets/sp/sp-2.htm).

*Road Salt and Water Quality*, WD-WMB-4, NHDES Fact Sheet, (603) 271-3503 or [www.des.state.nh.us/factsheets/wmb/wmb-4.htm](http://www.des.state.nh.us/factsheets/wmb/wmb-4.htm).

*Sand Dumping - Beach Construction*, WD-BB-15, NHDES Fact Sheet, (603) 271-3503 or [www.des.state.nh.us/factsheets/bb/bb-15.htm](http://www.des.state.nh.us/factsheets/bb/bb-15.htm).

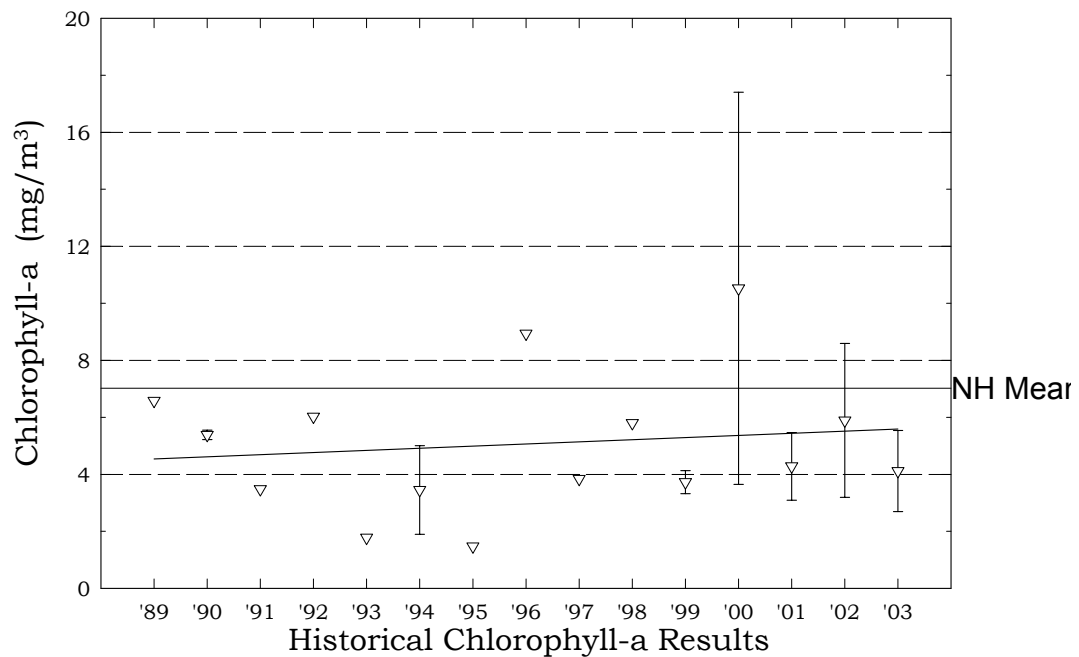
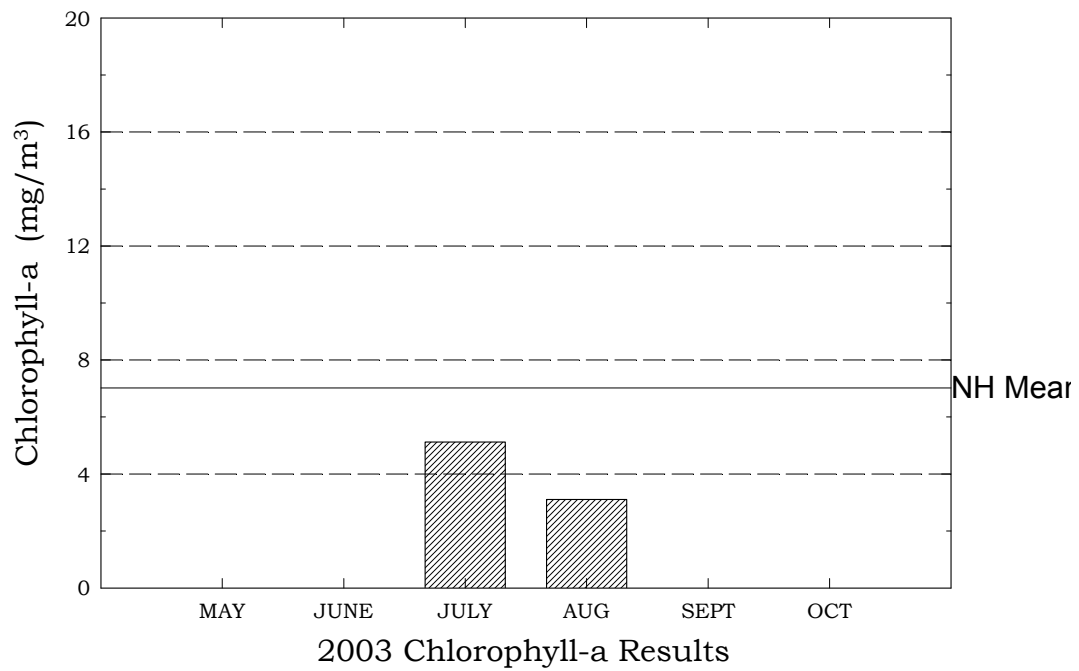
*Weed Watchers: An Association to Halt the Spread of Exotic Aquatic Plants*, WD-BB-4, NHDES Fact Sheet, (603) 271-3503 or [www.des.state.nh.us/factsheets/bb/bb-4.htm](http://www.des.state.nh.us/factsheets/bb/bb-4.htm).

# APPENDIX A

## GRAPHS

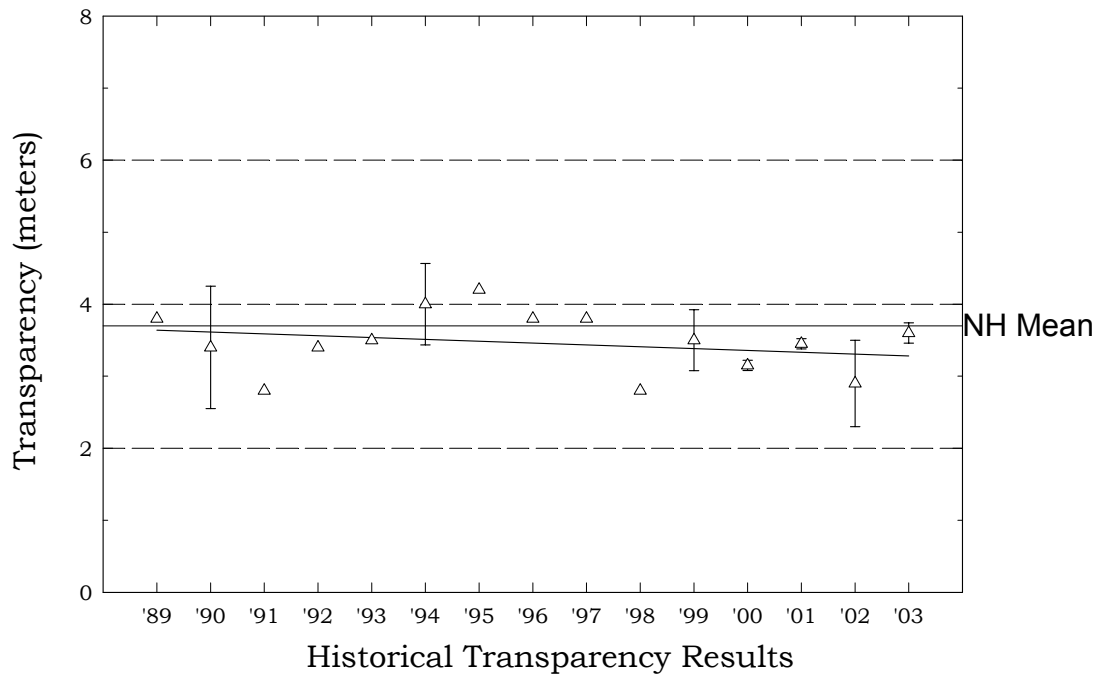
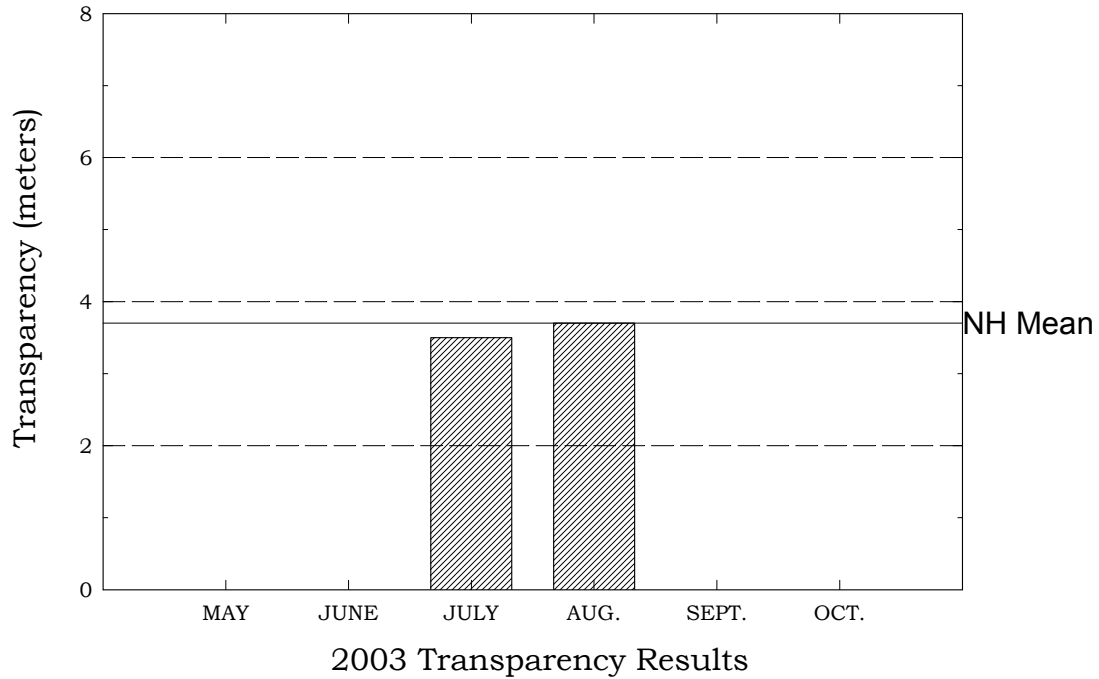
## White Oak Pond, Holderness

**Figure 1.** Monthly and Historical Chlorophyll-a Results



# White Oak Pond, Holderness

**Figure 2.** Monthly and Historical Transparency Results



## White Oak Pond, Holderness

**Figure 3.** Monthly and Historical Total Phosphorus Data.

